Chapter 4

Local Area Networks

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Local Area Network

L A N

- **LAN is to interconnect computers, printers, terminals(building or small set of buildings)**
- **LAN designers usually lay their own high-bandwidth cables.**
  - While long-haul networks use the public telephone network for economic reasons.
- **LAN can use simple access algorithms, not being forced to optimize bandwidth.**

ETHERNET

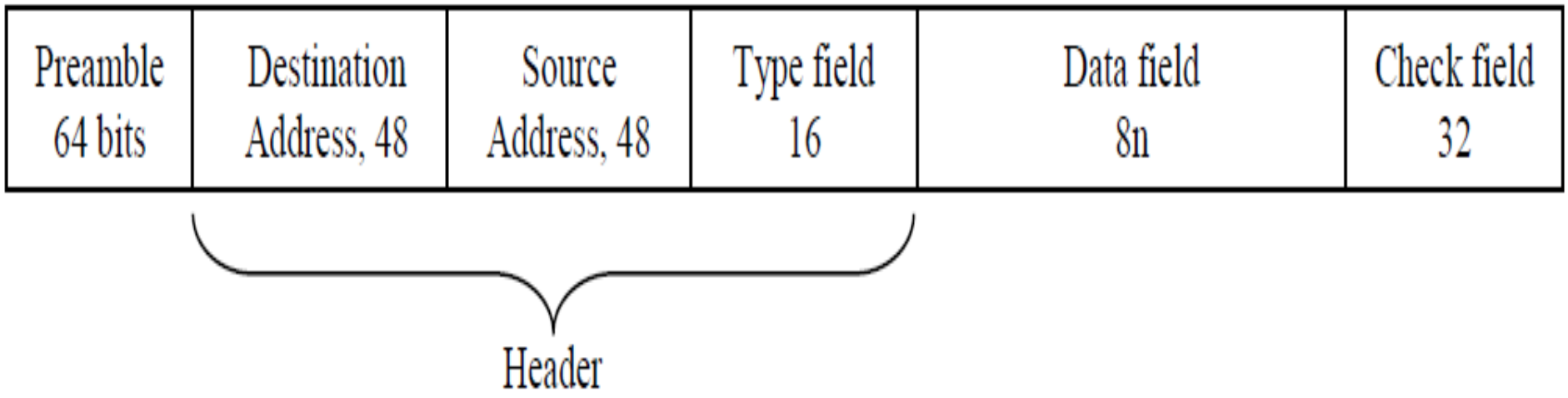
CARRIER-SENSE MULTIPLE ACCESS NETWORKS (ETHERNET)

- **Ethernet** is a LAN access scheme developed by the Xerox Corporation.
- Based on assumption that **each local machine can sense the state of a common broadcast channel before attempting to use it.**
- The technique is known as carrier-sense multiple access with **collision detection** (CSMA/CD).

Ethernet Bit Field Specification

- **Preamble**
  - Contains 64-bit synchronization pattern of alternating 1's and 0's ending with two consecutive ones.
  - (i.e., 1,0,1,0,1,0,1,0,…,1,0,1,0,1,0,1,1).
- **Header:**
  - Receiving station examines a **destination address** field in the header to see if it should accept a particular packet.
  - **Source address** is the address of the transmitting machine.
  - **Type field** determines how the data field is to be interpreted (e.g., data encoding, encryption, message priority, and so).
- **Data field** is an integer number of bytes from a minimum of 46 to a maximum of 1500.
  - Minimum spacing between packets is 9.6 μs.
- **Parity check** field is added for error detection.

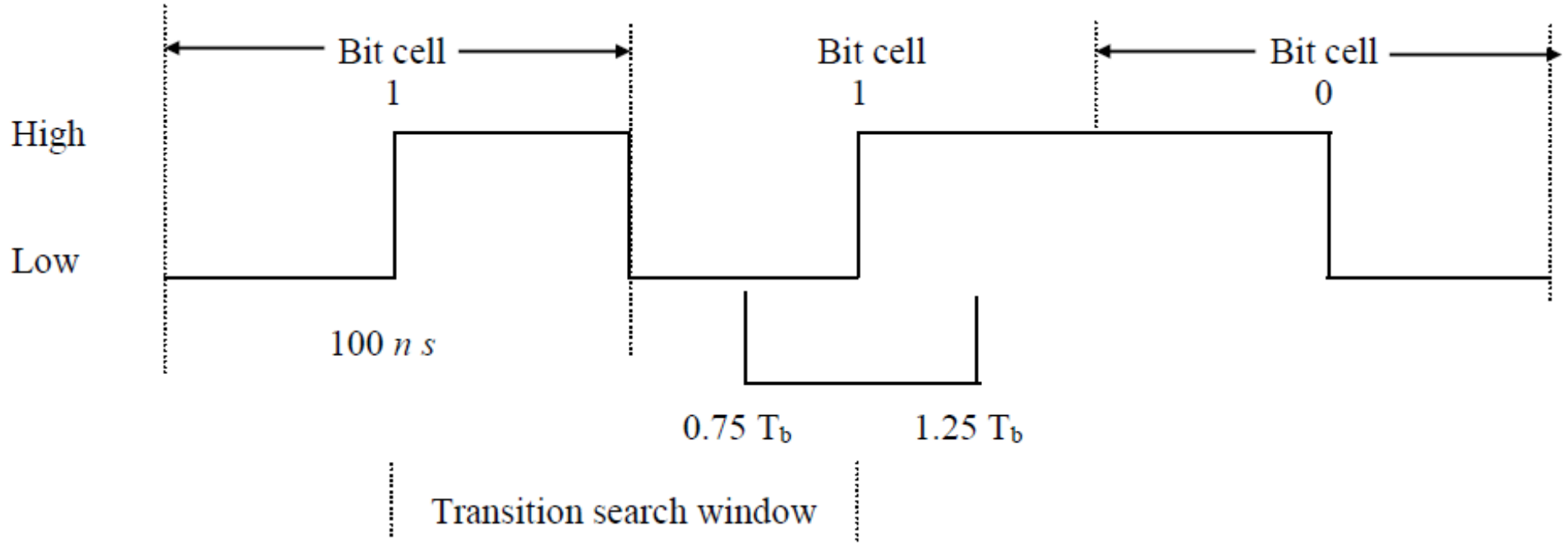
ETHERNET BIT FIELD SPECIFICATION



Data field

- **Maximum packet size is 1526 byte consists of:**
  - 8-byte preamble
  - 14-byte header
  - **1500-byte data**
  - 4-byte parity
- **Minimum packet size is 72 bytes consisting of:**
  - 8-byte preamble
  - 14-byte header
  - **46-byte data**
  - 4-byte parity
- **Minimum spacing between packets is 9.6 μs.**

10 Mbps data stream with Manchester PCM



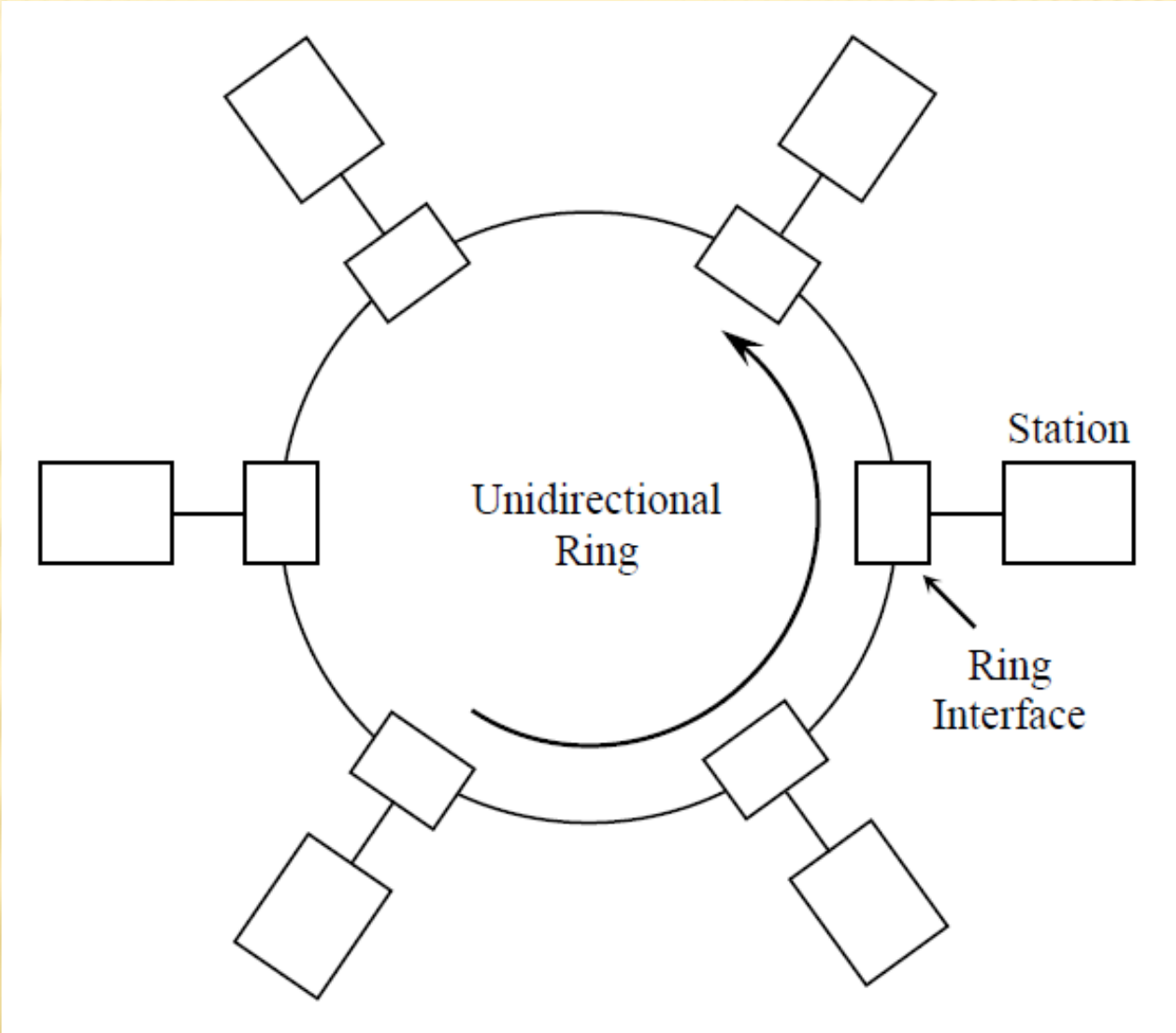
- Each bit position contains a transition.
- Presence of data transitions denotes to all listeners that carrier is present.
- If transition is not seen between 0.75 and 1.25 bit times since last transition,
  - Carrier has been lost, indicating end of a packet.

CSMA/CD, USER ACTION OR RESPONSE

- **Defer:** User must not transmit when the carrier is present or within the minimum packet spacing time.
- **Transmit:** User may transmit if not deferring (when carrier is not present until the end of packet) or if a collision is detected. If transition is not seen between 0.75 and 1.25 bit times since the last transition, carrier has been lost, indicating the end of packet.
- **Abort:** If collision is detected, user terminates packet transmission and transmits short jamming signal to ensure that all collision participants are aware of collision
- **Retransmit:** User must wait a random delay and then attempt retransmission.
- **Backoff:** Delay before n^{th} attempt is uniformly distributed random number from 0 to 2^{n-1} for $0 < n < 10$ of unit-time equivalent to 512 bits ($51.2\ \mu s = \frac{1}{10\ Mbit/sec} * 512\ bit$).

Token Ring

Token-Ring Networks



Token Ring and CSMA/CD

Comparison

- **CSMA/CD** is a cable onto which all stations are passively connected.
- **Token Ring** is a series of point-to-point cables between consecutive stations.
- Interfaces between the **Token Ring** and **stations** are **active** rather than **passive**.

Interface Modes

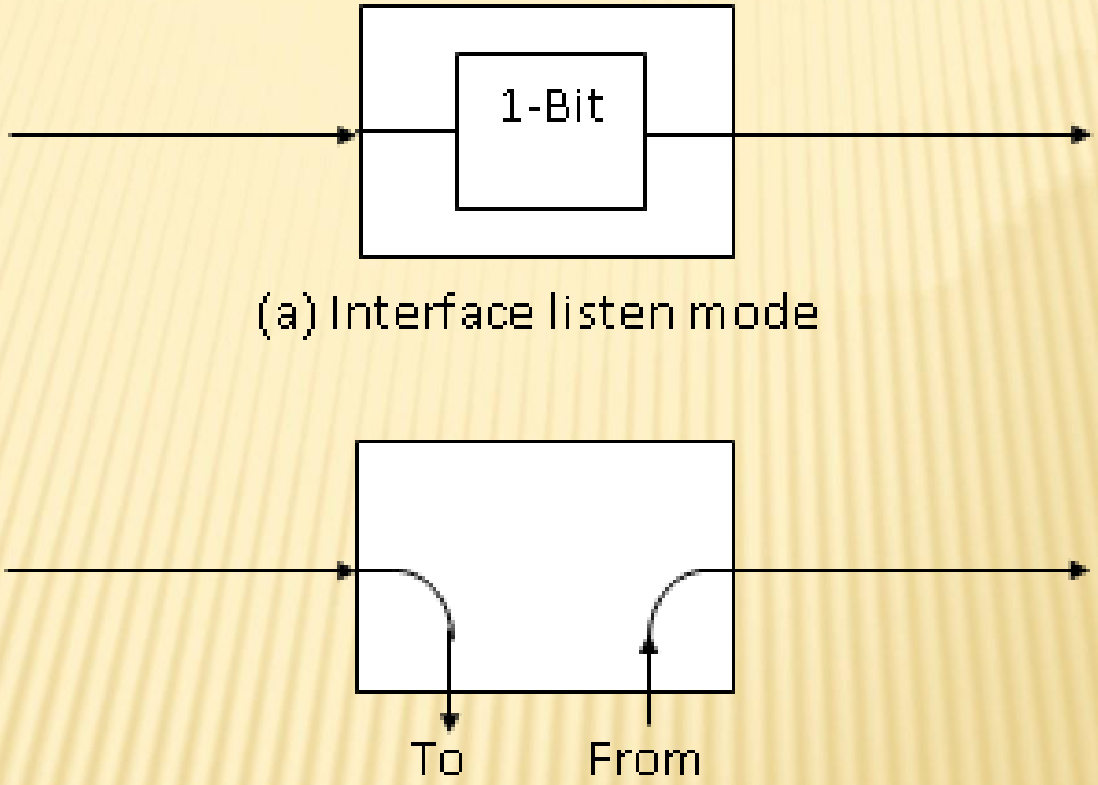
- **Listen mode:**

Input bits are copied to the output with a delay of one bit time

- **Transmit mode:**

Connection is broken so that the station can enter its own data onto the ring.

LISTEN AND TRANSMIT MODES



(a) Interface listen mode

(b) Interface transmit

Fig.3.15 Listen and Transmit Modes

The Token

- **Token is a special bit pattern.**
- For example:
  - **8-bit token** is: 1 1 1 1 1 1 1 1
  - **It circulates on the ring when all stations are idle**

Bit Stuffing

- **Used to prevent token pattern from occurring in the data.**
- **Bit stuffing algorithm:**
  - Insert zero into data stream after each sequence of seven ones.
  - Receiver would use a similar algorithm to ignore it

Token Ring Operation

- **Station monitors token appearing at interface.**
- **When the last bit of the taken appears, the station invert it (e.g., 1 1 1 1 1 1 1 0).**
- **Station then breaks the interface connection and enters its own data onto the ring.**
  - ✓ There is no limit on the size of the packets.
  - ✓ As bits come back around the ring, they are removed by the sender.
- **After transmitting the last bit of message, the station must regenerate the token.**
  - ✓ After last data bit has circled the ring and being removed
  - ✓ The interface is switched back to listen mode.

Contention

- Contention is not possible with a Token-ring system since there is only one token.
- During heavy traffic, the next station requiring service will see the token and remove it.
- So, permission to transmit rotates smoothly around the ring without contention.

Propagation Length

A major design parameter in ring network is the propagation length of a bit.

- If the data rate is *R* Mbps,
- A bit is emitted every 1/*R* μs.

Since the propagation rate along a typical coaxial cable is 200 meter / μs,

- Each bit occupies 200/*R* meters on ring

$$200\left(\frac{m}{\mu s}\right) * \frac{1}{R}\frac{1}{\left(\frac{M\,b}{s}\right)} = \frac{200}{R}\left(\frac{m}{b}\right)$$

Example

If 8-bit token is used on 5 Mbps token-ring, calculate min propagation distance d_P needed for ring circumference. Assume the propagation velocity v_P is $200\ m/\mu s$.

Answer

Time to emit one bit is given by:

$$t_b = \frac{1}{R} = \frac{1}{5\ M\ b/s} = \frac{1}{5}\left(\frac{\mu\ s}{b}\right)$$

Time to emit the full 8-bit Token ring:

$$t_{8\ bit-Token} = 8 * \frac{1}{5}\left(\frac{\mu\ s}{b}\right)$$

Propagation distance of Token through ring:

$$d_P = t_{8\ bit-Token} *\ v_P = 8 * \frac{1}{5}\left(\frac{\mu\ s}{b}\right) * 200\left(\frac{m}{\mu\ s}\right)$$

$$\therefore d_P = \frac{8}{5}\left(\frac{\mu\ s}{b}\right) * 200\left(\frac{m}{\mu\ s}\right) = 320\left(\frac{m}{b}\right)$$

CSMA/CD & TOKEN-RING COMPARISON

Delay-throughput characteristics of a CSMA/CD and Token-Ring.

Comparison is made for:

- **50 stations,**
- **1000 bits average packets,**
- **2km cable length, and**
- **The header length is 24 bits.**

Delay-throughput Characteristics